



# Hail

By Ashley Vedvig, NWS Student Volunteer, Spring 2013

## What is hail?

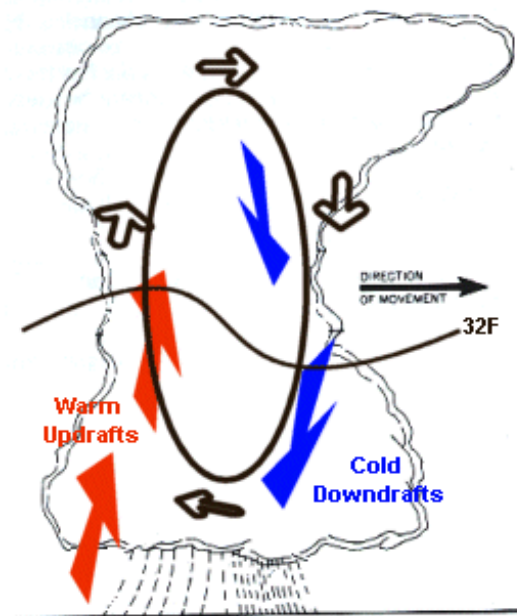
Hail is a form of precipitation that forms when an updraft carries water droplets up into the cooler atmosphere where it will freeze creating a ball of ice.

## How does it form?

It all depends on the updraft and downdraft within a thunderstorm. As the updraft becomes stronger, the thunderstorm grows taller, allowing water droplets in the updraft to reach altitudes where temperatures are well below freezing. This allows some of the water-droplets to freeze while others will remain in a liquid state even though temperatures are below freezing (these droplets are called super-cooled). Eventually, some of the frozen water-droplet will get into the downdraft, melting slightly as they fall. Some of these frozen water-droplets will be sucked back up into the updraft where they will be taken up for another ride. At this time they will freeze on contact with other ice crystals, other super-cooled water droplets, or dust forming yet larger droplets. This up-down cycle can be repeated several times which allows the hail stone to accumulate more layers of ice. This process continues until the hailstone becomes too heavy for the updraft to support it. When this happens, the hailstone will fall to the earth's surface.

This image demonstrates how hail will go up the updraft and come back down the downdraft only to be brought back up the updraft. The cycle continues until the hail becomes too heavy for the updraft to hold.

<http://www.erh.noaa.gov/er/cae/svrwx/hail.htm>



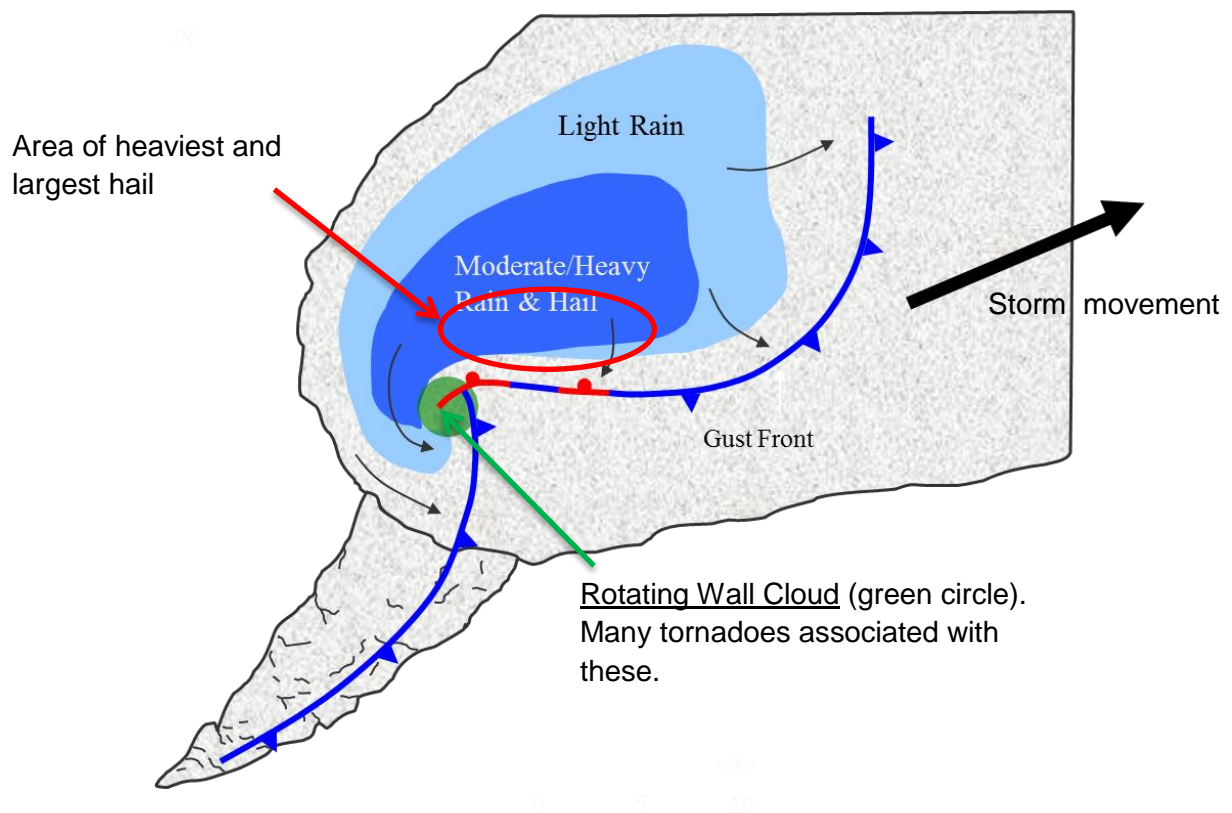
## Hail and Thunderstorms:

### Multi-cell Thunderstorm Hail:

Multi-cell thunderstorms will generate a large amount of hail but the hail stones do not tend to be very large. The updraft does not usually last long enough for the hailstone to grow large in size so often many small pieces of hail will fall from this type of thunderstorm.

### Supercell Thunderstorm Hail:

Supercell thunderstorms tend to have very strong, sustainable updrafts which provide ample growth time for the hailstones. This type of thunderstorm produces the large hailstones that can be very damaging. The largest hailstones will typically fall closest to the updraft. An idealized supercell thunderstorm example is illustrated below:



## Hail Shafts/Swaths:

As hail falls from the cloud it can sometimes appear as a white streak falling from the storm. It can be confused as a tornado but is simply a column of falling hail that extends out of the base of the cloud to the ground from which it gets its name Hail Shaft. A hail swath is hail that falls in paths. When viewed from the air, these swaths can range in size from a few acres to an area 10 miles wide and 100 miles long. Piles of hail in hail swaths have been so deep, a snow plow was required to remove them, and occasionally, hail drifts have been reported.



The white column extending out of the cloud is a hail shaft  
[http://www.crh.noaa.gov/news/display\\_cmsstory.php?wfo=mkx&storyid=29870&source=2](http://www.crh.noaa.gov/news/display_cmsstory.php?wfo=mkx&storyid=29870&source=2)

## Hailstone Size Classification

\*Once hail reaches 1 inch in diameter it is considered “severe”

<b>Pea</b>	<b>0.25-0.375 inch</b>	<b>Lime</b>	<b>2.00 inches</b>
<b>Small Marble</b>	<b>0.50 inch</b>	<b>Tennis Ball</b>	<b>2.50 inches</b>
<b>Penny</b>	<b>0.75 inch</b>	<b>Baseball</b>	<b>2.75 inches</b>
<b>Nickel</b>	<b>0.88 inch</b>	<b>Large Apple</b>	<b>3.00 inches</b>
<b>Quarter</b>	<b>1.00 inch</b>	<b>Softball</b>	<b>4.00 inches</b>
<b>Half Dollar</b>	<b>1.25 inch</b>	<b>Grapefruit</b>	<b>4.50 inches</b>
<b>Walnut/Ping Pong</b>	<b>1.50 inch</b>	<b>CD/DVD</b>	<b>4.75-5inches</b>
<b>Golf Ball</b>	<b>1.75 inch</b>		

## Hail Damage:

Hail causes nearly one billion dollars in damage each year in the United States. Much of this is due to agriculture crops being shredded by hailstones. It can damage aircrafts, homes, total automobiles, shatter windows, cause injuries or even fatalities.

- Hail has been known to injure about 24 people a year in the United States
- On March 28, 2000 in Lake Worth Village, Texas a 19-year-old male was killed after taking a softball size hailstone to the head while trying to move his car. It fractured his skull and he passed away the next day.
- Livestock have been known to be severely affected by hailstones. Farmers may lose a large number of their stock to one storm.
- Hail has even been known to cause a plane to crash. On April 4th, 1977, a Southern Airways DC-9 crashed in New Hope, GA. Hail got into both of the engines causing them to lose thrust. The impact killed 62 people on the plane, 8 people on the ground and only 23 people survived the crash.
- In any given year, hail can result in well over \$1 Billion in property and crop damage in the U.S. For statistics related to all severe weather hazards refer to this web page: <http://www.nws.noaa.gov/os/hazstats.shtml>



Hail destroyed the siding of this home

[http://www.noaa.gov/features/03\\_protecting/hail.html](http://www.noaa.gov/features/03_protecting/hail.html)



NOAA vehicle damaged by hail

<http://www.photolib.noaa.gov/700s/nssl0257.jpg>

## Significant Wisconsin Hailstorms:

- Southern Wisconsin April 13, 2006: [http://www.crh.noaa.gov/mkx/?n=041306\\_hail](http://www.crh.noaa.gov/mkx/?n=041306_hail)
- South-central Wisconsin July 24, 2009: [http://www.crh.noaa.gov/mkx/?n=latejuly\\_2009\\_svrwx](http://www.crh.noaa.gov/mkx/?n=latejuly_2009_svrwx)
- Southern Wisconsin October 23-24, 2001: [http://www.crh.noaa.gov/mkx/document/other/hail\\_10-23-01.php](http://www.crh.noaa.gov/mkx/document/other/hail_10-23-01.php)
- Central Wisconsin June 7, 2007: <http://www.crh.noaa.gov/grb/?n=070607>
- Northeast Wisconsin July 1, 2006: <http://www.crh.noaa.gov/grb/?n=060701>
- East-central Wisconsin May 12, 2000: <http://www.crh.noaa.gov/grb/events/051200.php>
- Southwest Wisconsin September 4-5, 2012: <http://www.crh.noaa.gov/arx/?n=sep0412>
- La Crosse area April 10, 2011: <http://www.crh.noaa.gov/arx/?n=apr1011>



## Hail Safety Tips

It is important to remain indoors during a thunderstorm that produces hail. Hail is taken very lightly by most people but it has been known to injure and even kill people. Some safety tips to keep in mind when there is hail, if you are:

### Inside a building:

- Stay away from windows and stay off of your porch; wind-blown hail can shatter your windows.
- Do not go outside to see the hail. Once you go outside you are exposed to other threats that come along with thunderstorms such as lightning, and strong winds.



Windows and siding destroyed by hail

[http://www.srh.noaa.gov/images/lub/events/2012/20120429-storms/mobile\\_home\\_damage\\_bq.jpg](http://www.srh.noaa.gov/images/lub/events/2012/20120429-storms/mobile_home_damage_bq.jpg)

### Driving:

- Pull over into a parking lot or gas station (If you happen to get stuck on a highway or road, pull over and put your emergency lights on)
- Do not stop in the middle of the road! Especially under an overpass or bridge! This may lead to accidents and also prevent emergency vehicles from getting to their intended destinations.
- Use a blanket or coat to cover yourself in case your windshield breaks.
- If you are in a Truck, Van, or SUV move to the middle of the vehicle and get away from the front windshield if possible.
- Stay away from sun/moon roofs as these can shatter letting more hail into the vehicle.
- Do not leave your vehicle until it stops hailing; your car is reasonable protection.
- Get onto the floor face down if possible; if not put your seat down and lay down with your back to the window. Put small children underneath you and protect their eyes from possible shattered windows.



Aftermath of a hailstorm

<http://www.photolib.noaa.gov/bigs/nssl0003.jpg>

### Outside:

- Get inside a building or a vehicle as soon as possible! (Building is preferred)
- If no vehicle or building is near you, use whatever you can to shield yourself from the hail.
  - If you are unable to find anything, focus on protecting your head and neck with your arms since these areas are highly susceptible to injuries.
  - Anything you can get your hands on would be beneficial for shielding yourself, such as a bike helmet or piece of plywood. However, keep in mind that tents or other canvas awnings/shelters will not be much protection because hail can shred that very quickly.

## **Common Myths about Hail:**

### **Does a hailstorm mean that there will be a tornado?**

Hail is not a definite indicator of a tornado. The strong updraft and downdraft needed for hail production are also indicators that tornadic activity could occur but it is never guaranteed. Just because a storm does not produce hail does not mean it won't produce a tornado and vice versa. It is important then when severe weather comes into your area that you stay alert and informed. Seek shelter immediately and look for information on the current weather conditions.

### **Is there a way to simply look at a thunderstorm and tell if it will produce hail?**

There is no 100% accurate way to tell if a thunderstorm will produce hail by just looking at it. However, many people have noted that the thunderstorm cloud tends to have a "green" color when it produces hail. This probably due to light being split up into its components as it passes through hailstones with the green color being scattered the most. Meteorologists will use radar to "look inside" the storm. Doppler radar can estimate if there will be hail and what size the hail might be depending on the amount of energy reflected back to the radar by the storm.

## **Fun Facts about Hail:**

### **Ever wonder why it turns green outside before/during a thunderstorm?**

Some scientists say that when there is hail in a thunderstorm, the sky will turn green due to green light being reflected off of the hailstones within the thunderstorm. Unfortunately, this is not an official indicator that it will hail on the ground, even though that green light is visible. The hail may melt before it reaches the ground, but there was hail in the thunderstorm clouds.

### **How fast does hail fall?**

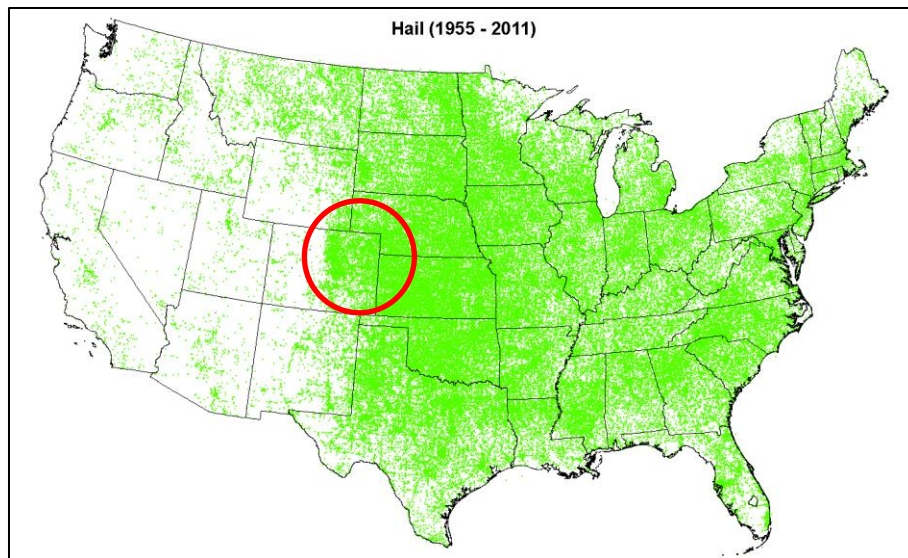
Once hail falls from the thunderstorm, a softball-sized hailstone could reach speeds of 100 miles per hour!

### **Where does hail occur?**

Hail occurs all across the United States; it can happen in any state, anytime, anywhere! Convective, warm-season hail has been documented all continents except Antarctica. Locations with the highest hail frequency (days) include northern India, eastern Russia, Andes Mountains of Ecuador and Peru, Kenya and eastern South Africa and southeast Wyoming to Oklahoma and northern Texas.

## United States “Hail Alley”

Florida has the largest amount of thunderstorms but because it is so warm there, other areas of the United States will see more hail. Nebraska, Colorado, and the Wyoming region have the highest number of hail events. The area where these three states meet is referred to as “Hail Alley”. The reason for this large amount of hail is that the freezing level (where the atmosphere reaches 32°F) is closer to the ground than at sea-level giving hailstones little time to melt before it reaches the ground. Places near sea-level have freezing levels high up in the atmosphere, giving the hail plenty of time to melt before it reaches the ground. Below is a map of hail events across the United States.



Hail Reports from 1955-2011

<http://www.spc.noaa.gov/gis/svrgis/>

## United States Record Hail:

On July 23<sup>rd</sup>, 2010 in Vivian, South Dakota, a hailstone was recorded with a diameter of 8 inches! It was 18.625 inches in circumference and weighed in at 1.9375 pounds! This hailstone alone broke the record for largest diameter (previously 7.0 inches) and heaviest hailstone (previously 1.67 pounds) but did not break the record for largest circumference! That record is still being held by the Aurora, Nebraska hailstone on June 22<sup>nd</sup>, 2003 that had a circumference of 18.75 inches!



Largest Hail Stone-Divot in the ground

<http://www.crh.noaa.gov/images/abr/Vivian/divot%20in%20ground%20from%20large%20hail.jpg>



Vivian, South Dakota Hailstone

<http://www.crh.noaa.gov/images/abr/Vivian/Diameter.jpg>

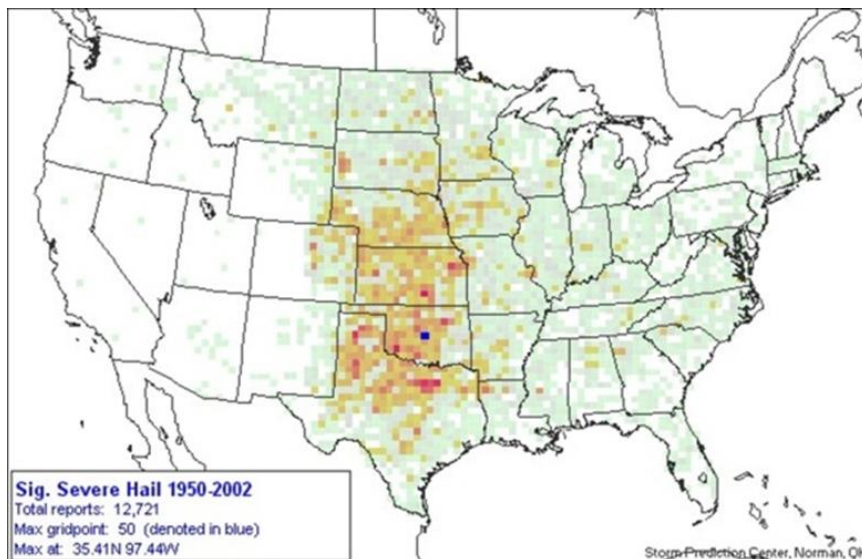
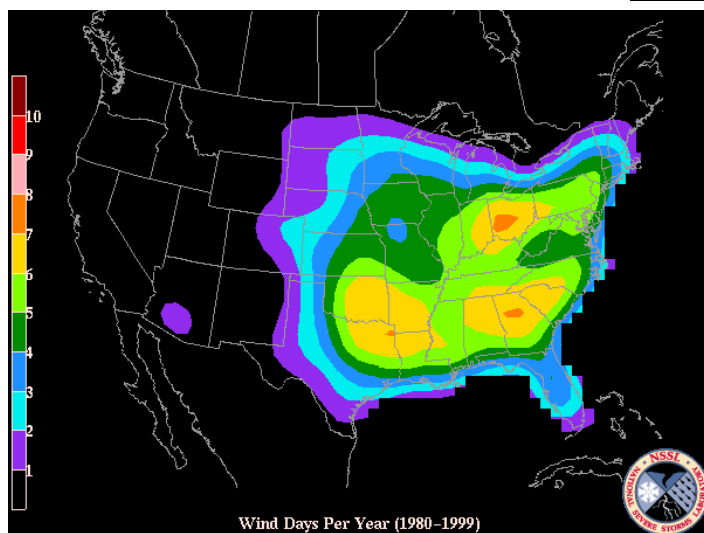
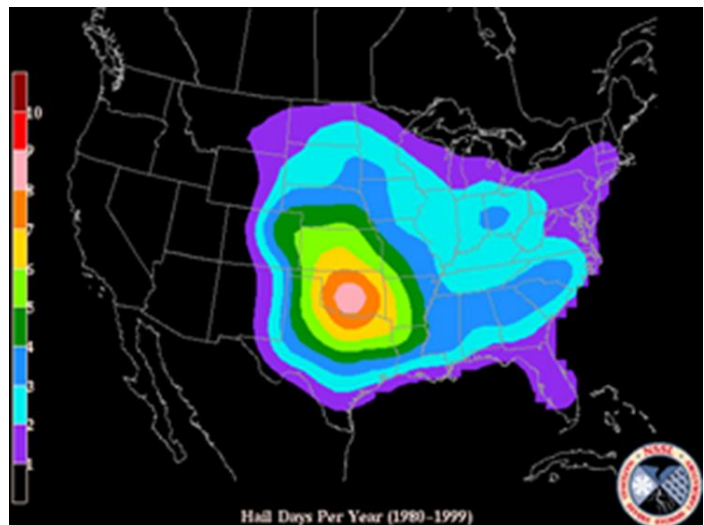


The map to the right is showing the number of hail days an area is likely to experience.

The map below shows locations that are most likely to receive thunderstorm winds of 50 knots or greater. Both of these maps are showing data from 1980-1999.

Additional related info:

<http://www.spc.noaa.gov/wcm/>



The map to the left is showing significant severe hail that has occurred from 1950-2002. There was a total of 12,721 reports and the blue dot in the middle of Oklahoma shows the maximum number of points, at 50.

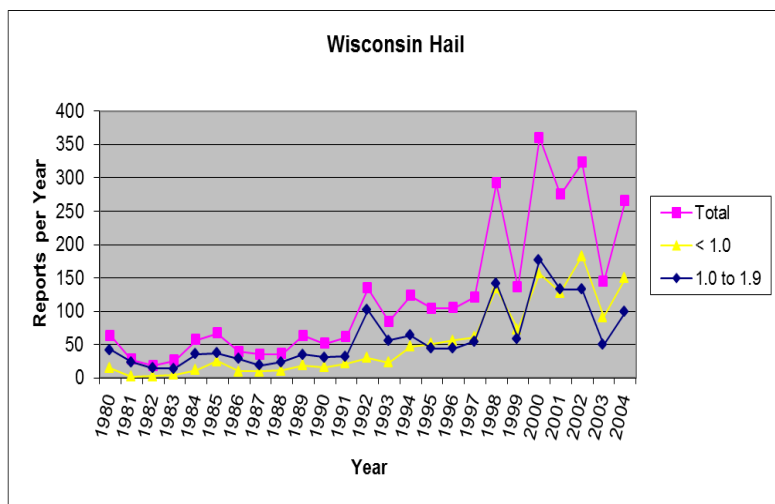


## Wisconsin Hail:

Large amounts of hail are not common in Wisconsin. The peak season for hail is April-August although hail has been reported with thunderstorms during every month. The southern half of Wisconsin tends to see the most hail; however it can occur anywhere across the entire state.

The largest hailstone recorded in Wisconsin was 5.7 inches in diameter and fell near Wausau in May of 1921. As the storm moved into Marathon County the hail grew from walnut- sized to oranges, then to apple-sized and even larger! Many trees were defoliated from this storm along with many broken windows and some minor injuries.

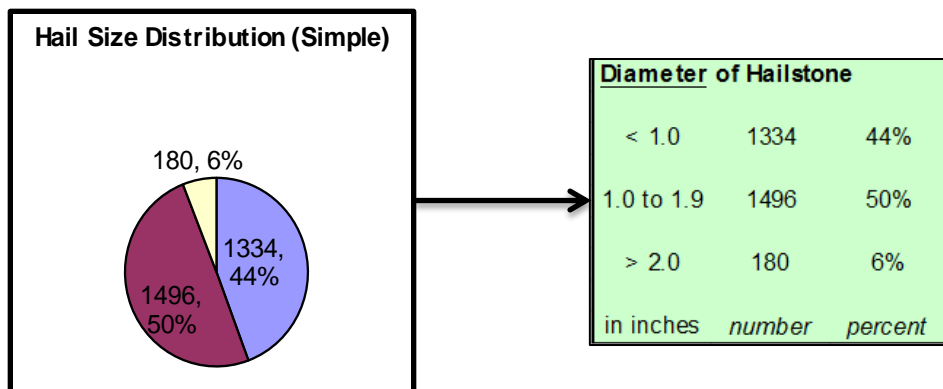
The second largest hailstone fell in Port Edwards on June 7<sup>th</sup>, 2007 with a diameter of 5.5 inches.



The graph on the left shows hailstone size in Wisconsin from 1980 to 2004. The yellow line indicated hail stones 1 inch or smaller. The navy blue line indicated hailstones from 1 inch to 1.9 inches. The pink line shows the total number of hailstones for the given year.


Enhanced NWS documentation efforts, better spotter networks and increased population was a factor in increased hail reports over the years.

This graph was created by Jordan Gerth, NWS Student Volunteer



This graph depicts the ratio of hailstone sizes from 1980-2004. The magenta color represents the hailstones that are 1 inch to 1.9 inches in size. The lavender color represents the hailstones that are smaller than 1 inch. The tan color represents the number of hail stones that are larger than 2 inches. This graph was created by Jordan Gerth, NWS Student Volunteer

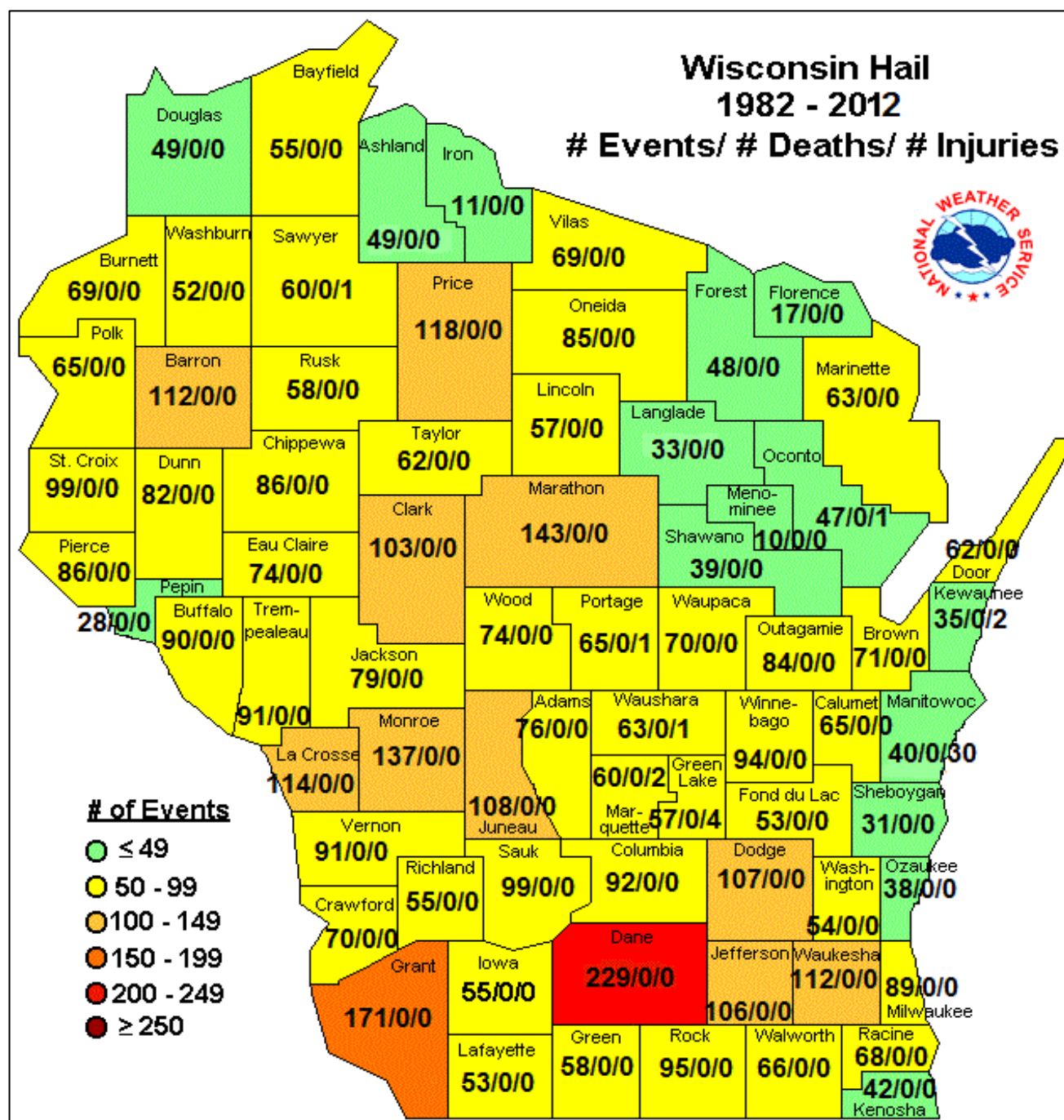
<http://www.ncdc.noaa.gov/IPS/sd/sd.html;jsessionid=24446893763BBC54DD4F2728B976A1F7>

Wisconsin Hail Reporting Statistics								National Weather Service		
Number of Hail Reports by Category (size)										
Year	Total	< 1.0	1.0 to 1.9	> 2.0	Crp Dm	Prp Dm	Total Dm	Crp Amt	Prp Amt	Total Amt
1980	63	15	42	6	 <b>Property and crop damage</b> was not recorded until 1993.					
1981	27	2	24	1						
1982	18	3	15	0						
1983	26	5	14	7						
1984	57	12	36	9						
1985	67	25	37	5						
1986	39	10	29	0						
1987	35	10	19	6						
1988	36	11	24	1						
1989	63	19	35	9						
1990	51	16	31	4						
1991	61	22	32	7						
1992	134	30	102	2						
1993	84	23	56	5	4	6	10	\$16	\$24	\$40
1994	123	47	64	12	2	12	14	\$50	\$345	\$395
1995	104	51	44	9	1	2	3	\$1	\$13	\$14
1996	105	56	44	5	0	4	4	\$0	\$1,303	\$1,303
1997	121	61	55	5	21	16	37	\$772	\$563	\$1,335
1998	292	134	142	16	33	34	67	\$863	\$756	\$1,619
1999	136	73	59	4	4	12	16	\$70	\$658	\$728
2000	360	157	177	26	35	66	101	\$9,529	\$119,064	\$128,593
2001	275	128	133	14	18	39	57	\$129	\$22,995	\$23,124
2002	323	183	133	7	5	13	18	\$111	\$5,521	\$5,632
2003	144	91	50	3	13	3	16	\$91	\$52	\$143
2004	266	150	99	17	7	25	32	\$1,029	\$6,837	\$7,866
2005	235	134	96	5	4	17	21	\$2,709	\$30,254	\$32,963
2006	91	60	30	1	12	14	26	\$233	\$1,097	\$1,330
2007	300	178	114	8	5	19	24	\$31	\$46,080	\$46,111
2008	368	215	131	22	4	13	17	\$39	\$388	\$427
2009	153	70	76	7	31	31	62	\$29,545	\$4,595	\$34,140
2010	191	74	112	5	3	8	11	\$362	\$16,527	\$16,889
2011	394	98	252	44	0	17	17	\$0	\$34,123	\$34,123
2012	252	101	145	6	1	11	12	\$50	\$4,578	\$4,628
Through December 31, 2012										
Total	4994	2264	2319	278	203	362	565	\$45,630	\$295,772	\$341,403
								in thousands of dollars		
	Hailstone size in inches									
	Jordan Gerth, 12/29/2004				Note for Crp Dm, Prp Dm, Total Dm, Crp Amt, Prp Amt, Total Amt					
	Ashley Vedvig, 2,26,2013				Only events which produced more than \$1000 in damage included					

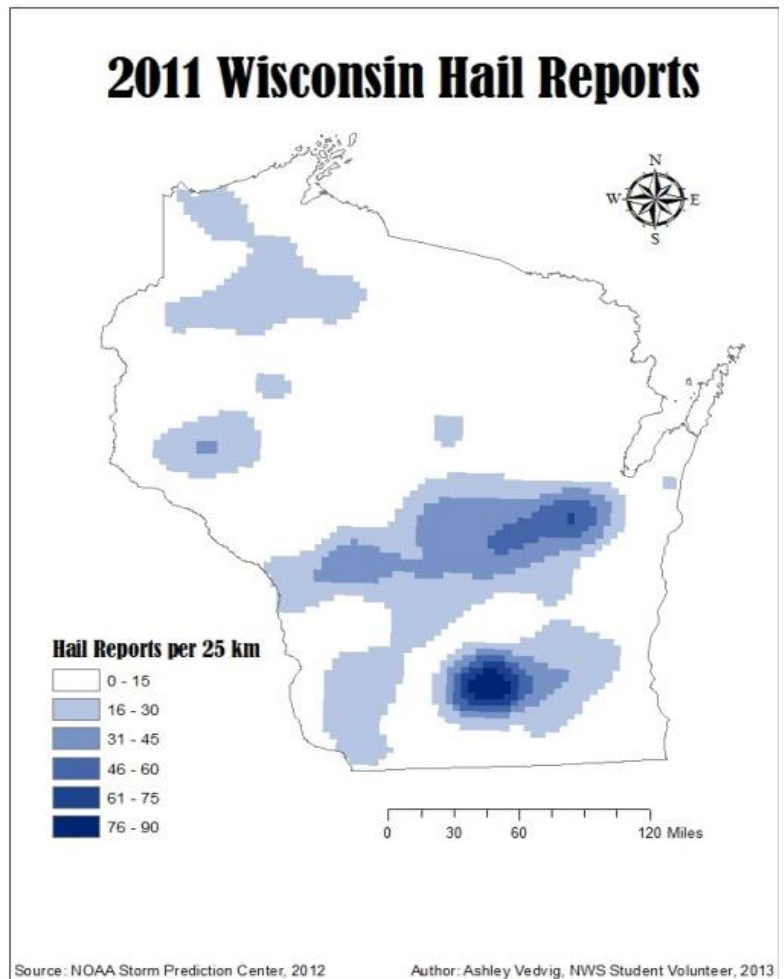
The map below documents all hail occurrences (hailstones 3/4 inch in diameter or larger) by county, as well as deaths, and injuries inflicted by hail for the years of 1982-2012.

Larger and/or more populated counties obviously will tend to have greater event bean-counts. For example, if we combine Jefferson and Waukesha County together, our combined county is roughly equal to the size of Dane County. Our hail event total for our combined county is 218, which is comparable to Dane County's numbers.

Nonetheless, there are fewer large hail events closer to the Great Lakes due to the thunderstorm energy-dampening effects of the cooler air over the Great Lakes



The map on the right depicts all hail reports for the year of 2011. The reason you see such a concentration of hail reports in the south-central part of the state is that it is more populated, leading to more reports. Madison, for example, when hit by a storm, will have more hail reports than a smaller city would.



## PING Project:

The Ping Project stands for **P**recipitation **I**dentification **N**ear the **G**round Project and is an app that you can use on your phone! The National Severe Storms Laboratory is trying to collect data about precipitation on the ground that may be happening in your area. Anyone can be a volunteer! All you need to do is download the PING app and when there is precipitation in your area, whether it is rain, hail or snow, you can report it. During storms, radar cannot tell what is happening on the ground so the National Severe Storms Laboratory is looking to you to report what is happening in your area. Meteorologists will compare what is happening on radar with what you are experiencing to help them develop more accurate radar technologies. If you cannot get the app, feel free to use their website and report the precipitation that you are experiencing. You may download the app via the Apple Store.

Here is a link to the PING Project website:

<http://www.nssl.noaa.gov/projects/ping/>